

EVALUATING HAY QUALITY

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One of the frustrations to nutritionists interested in the feeding value of roughage has been that with all their book knowledge and technical aids no dependable scheme they could devise would consistently rank forages in feeding value, while the dumb ruminant animal could unerringly detect differences in their nutritive values.

E. W. Crampton, 1965

Presumably hay has been evaluated by some method from the time it was first made and fed to animals. However, it was not until 1816 that chemical tests of forages were made to ascertain their feeding values. In England, Sir John Sinclair grew experimental plots of a number of plants and Sir Humphrey Davy analyzed them.

Many advances have been made since those studies 171 years ago. Today we can analyze a hay and a silage, corn, oats, and a few other ingredients and calculate a balanced ration for a dairy cow or a horse in approximately half the time that I will be talking to you. I want to highlight how we have come to be where we are in determining hay quality for feeding livestock and indicate some of the implications of the latest advances.

The Succeeding 150 Years

The proximate analysis procedure of Henneberg and Stohmann was published in 1864. It was used world-wide as the standard method of evaluation for nearly 100 years. In 1955 the "artificial rumen" or in vitro procedure for determining digestibility was described. It was quickly adopted and, with modifications, is still used very widely. Crampton (1957) and Crampton et al. (1960) emphasized the importance of voluntary intake in determining a forage's value when it is fed alone and developed an evaluation procedure which they called "nutritive value index".

In the 1960s Peter Van Soest published several papers dealing with forage analysis and his methods for determining fiber were adopted world-wide, also. The in vitro and Van Soest methods were great advances, even though they were laborious and expensive in routine laboratory use.

As useful as the in vitro and Van Soest analyses have proved to be they are too time-consuming for many applications, including analyses of forages used in everyday livestock feeding operations and in hay marketing. Therefore, researchers continued to seek more rapid analytical procedures which would be sufficiently accurate and, hopefully, less expensive.

The Last 20 Years

For several years Karl Norris, head of the Instrument Research Laboratory at the USDA's Beltsville, MD agricultural research facility, had been investigating use of near infrared reflectance spectroscopy (NIRS) for determining moisture and protein in grain crops, especially wheat. Potential use of that technology in determining composition of forages was suggested in April 1975 at a workshop, co-sponsored by USDA/ARS and AFGC in Beltsville.

As a result, cooperative research between USDA/ARS and The Pennsylvania State University was initiated in June 1975 to investigate use of NIRS in evaluating feeding value of forages and the first paper on the research results appeared the next year (Norris et al., 1976). A national research project was organized in November 1978, with six laboratories cooperating.

That project has proved to be even more productive than was envisioned at the beginning. Today, a long list of forages, grains, supplements, and mixed feeds can be analyzed, requiring only a minute or so for each sample. Then, with appropriate computer programs, balanced rations can be formulated for feeding a given kind of animal. A need which NIRS does not fill is information on trace-element composition. Dairy-cattle owners and horse men, especially, would welcome that information along with the analyses obtained through NIRS.

Hay Analysis and Marketing

Until recently few livestock producers made the effort to have their hays analyzed. As a matter of fact, even high-quality hays and pasturage were referred to as "roughages", suggesting something of low value. Several factors have caused that situation to change, among them the cost-price squeeze in which dairymen found themselves. In looking for ways to cut costs, they have used more forages, as well as forages of improved quality. They realized before other livestock people, I think, that high-quality forages are very valuable in a feeding program. More and more leading dairymen have been demanding chemical analyses of the hays they are buying, as well as having their own tested.

USDA established grades for hays several decades ago, but they were never widely used by U. S. feeders. The grades were based to considerable degree on organoleptic properties, i. e., those which can be detected by the human senses (sight, smell, touch) and are, therefore, determined subjectively. Moreover, such a grading system has little, if any, usefulness in rational feeding programs, as chemical composition does not enter into grade determination. The USDA grades are, therefore, no longer used.

Most of the hay which is fed on farms where it is produced is used without much, if any, idea of its nutritive value. Thus, the typical producer who feeds hay to his animals has little information on its contributions to the animals' nutritive requirements. The hay is, therefore, utilized inefficiently, being almost always either under- or over-supplemented. This situation has existed in spite of the well-known fact that quality of hays varies far more than that of grains and most other feedstuffs.

Over the years several procedures have been proposed or used for determining hay quality. California has used the modified crude fiber procedure for approximately 25 years, but no other state has adopted it. When hay has been shipped into or out of California accompanied by an analysis, confusion has been the typical result.

Several years ago AFGC established a Hay Marketing Task Force. After considerable effort the group developed and proposed hay grades for (1) legumes and legume mixtures and (2) grasses and grass-legume mixtures (Rohweder et al., 1978). The proposed grades were widely discussed but never officially adopted.

Another factor leading to change was the interest of the National Hay Association (NHA) in improving grading and marketing procedures. With so much interest in improving the situation and with the availability of NIRS technology, it seemed only natural to attempt to utilize the improved analytical procedures to decrease confusion and increase the efficiency of utilizing and marketing hay.

National Alfalfa Hay Quality Committee

The National Alfalfa Hay Quality Committee (NAHQC) was formed in late 1982, with representatives from several interested organizations, to develop an analytical procedure for alfalfa hay which could be used on a trial basis throughout the U. S. If found sufficiently useful, it was hoped that the procedure would then be adopted as a uniform, national method for expressing quality of alfalfa hay. After several meetings NAHQC agreed on the following procedure (Subcommittee on Laboratory Certification of the U. S. Alfalfa Hay Quality Committee, 1984):

1. Energy values are to be expressed as digestible dry matter (DDM),
2. DDM will be calculated from acid detergent fiber (ADF) only,
3. Laboratory determinations are to include and be reported as per cent crude protein, CP (dry-weight basis); per cent ADF (dry-weight basis); per cent dry matter, DM (on an as-received basis); and estimated digestible dry matter (EDDM);
4. Additional optional, organoleptic factors can be added; and
5. CP, ADF, and DM may be determined by any method that gives results within the acceptable range established by a (to be agreed upon) certifying agency.

The procedure was presented at a national meeting in Chicago March 22-23, 1984 and met with almost complete support from those in attendance. Procedures for certification of laboratories were then developed, and 68 had been certified by 1987. The certifying agency is the National Alfalfa Hay Testing Association, P. O. Box 1059, Jackson, MI 49204. AFGC and NHA provided some financial support to initiate the activity and several states are using the NAHQC procedures. Some states are asking laboratories to supply additional information over and above that suggested by NAHQC. For example, Wisconsin uses a "relative feed value" (RFV), which is based on estimates of intake and digestibility of the forage.

Florida prefers use of a "quality index" (QI), which is an expression of free-choice TDN intake as a multiple of TDN required for maintenance. A QI of 1.0, for example, means that a growing heifer would be expected to just maintain her weight when fed the forage as the sole diet, while a forage with a QI of 2.0 would allow a gain of 1.6 pounds per day.

Implications for Producers, Vendors, Purchasers, and Users of Hay

NIRS analysis is being adopted rapidly in the developed countries of the world, as well as in some less-developed ones. The procedure is extremely rapid, accurate, and repeatable (Marten et al., 1985). With the availability of NIRS analysis and ration-balancing programs there is no longer any need to guess or use "book values" for composition of forages when feeding livestock. Feeding hay to dairy cows, for example, without knowing its chemical composition is almost certain to result in over- or under-supplementation if concentrates are also fed. The degree of

error will depend on the cows' nutritive requirements and the actual nutritive value of the hay.

Use of a mobile NIRS testing unit permits analysis of hays to be sold at auction soon after their arrival at the market. Quality values can be placed on the different lots before sale so that both vendor and buyer can know the hays' merits or deficiencies.

It seems to me that the availability of NIRS testing provides Kentucky alfalfa growers a great opportunity. Prevailing weather patterns in the state cause haymaking to be hazardous, especially in spring. With the availability of rapid analyses, producers can analyze their hays, segregate them by quality lots, and feed or sell in accordance with their own needs and market demands. Lower-quality, rain-damaged hays could be fed to beef cattle, for example, while the higher quality hays could be sold, at a premium, to horsemen and dairymen.

In 1986 Kentucky ranked 7th among the states in production of hays other than alfalfa, but 27th in alfalfa production. Much of the "other hay" acreage can be converted to alfalfa if well-drained soils are chosen and appropriate management practices are followed. Total hay production would then increase markedly and the state's producers, emphasizing quality hay with a chemical analysis, could become far more competitive in the marketplace than they have been.

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